National Transportation Safety Board
Aviation Incident Final Report

Location:	WASHINGTON, DC	**Incident Number:**	CHI95IA138
Date & Time:	04/27/1995, 1735 EDT	**Registration:**	N331NW
Aircraft:	Airbus Industrie A320-211	**Aircraft Damage:**	None
Defining Event:		**Injuries:**	108 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

THE PILOT REPORTED THAT DURING THE VISUAL APPROACH TO RUNWAY 18, THE AIRPLANE ENTERED UNCOMMANDED ROLLS. A GO-AROUND WAS PERFORMED. ACCORDING TO THE PILOT, ON THE SECOND APPROACH THE AIRPLANE ONCE AGAIN EXPERIENCED AN UNCOMMANDED ROLL. THE AIRPLANE WAS LANDED. FDR DATA SHOWS THE ROLL OSCILLATIONS WITH A MAX ROLL OF 15.5 DEGREES. DURING THIS TIME THE SIDE STICK WAS BEING MOVED BACK AND FORTH TO ITS FULL TRAVEL LIMITS. THE AIRPLANE MOVEMENTS AND THE PILOT'S ACTIONS ARE CONSISTENT WITH PILOT INDUCED OSCILLATIONS (PIO). THE AIRPLANE WAS BEING LANDED IN CONF 3 (20 DEGREES OF FLAPS) WHICH MAKES THE HANDLING CHARACTERISTICS OF THE AIRPLANE 'MORE CRISP'. IN 1993 AIRBUS PUBLISHED A TEMPORARY REVISION TO THE AIRPLANE'S FLIGHT CREW OPERATING MANUAL STATING THE AIRPLANE SHOULD NOT BE LANDED IN ADVERSE WEATHER CONDITIONS (GUSTY WINDS AND TURBULENCE) IN CONF 3 DUE TO THE POSSIBILITY OF PIO. NORTHWEST AIRLINES HAD NOT INCORPORATED THIS INFORMATION IN THEIR OPERATING MANUALS.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: the pilot's excessive use of the flight controls during the landing approach, the company's disregard of information provided by the airplane manufacturer, and the company's failure to identify a potentially hazardous conditions based on the information provided by the airplane manufacturer. Factors associated with the incident were the gusty wind conditions and the pilot's failure to land with full flaps.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: APPROACH - VFR PATTERN - FINAL APPROACH

Findings
1. (F) WEATHER CONDITION - GUSTS
2. (F) LOWERING OF FLAPS - INADEQUATE - PILOT IN COMMAND
3. (C) FLIGHT CONTROLS - EXCESSIVE - PILOT IN COMMAND
4. (C) UNSAFE/HAZARDOUS CONDITION - NOT IDENTIFIED - COMPANY/OPERATOR MANAGEMENT
5. (C) INFORMATION - DISREGARDED - COMPANY/OPERATOR MANAGEMENT

Factual Information

History of Flight

On April 27, 1995, about 1735 eastern daylight time, Northwest Airlines flight 352, an Airbus A320-211, N331NW, while on visual approach to runway 18 at Washington National Airport, experienced what the Captain reported as several uncommanded roll oscillations up to 30 degrees of bank. The crew executed a go-around. On the second approach another roll was experienced and the crew landed the airplane. There was no damage to the aircraft. The flight crew, cabin crew, and passengers did not report any injuries.

The Captain's report of the incident stated, "Below 200 ft aircraft started rolling left and right. Max stick couldn't control the aircraft. Went around. On second approach at 50 ft aircraft started to roll again. We landed. We were 7 miles behind a 757 and a 727 took off just before we landed. No mech faults found."

Diagnostics were conducted on the flight control systems and no reason for the roll oscillations was found. The airplane was placed back in service.

Meteorological Information

Winds reported at National Airport, at 1750 edt, were from 180 degrees at 17 knots with peak winds from 220 degrees at 26 knots.

Flight Recorders

The digital flight data recorder (DFDR) was removed from the airplane. A review of the DFDR data for the first approach revealed, "While maintaining a rate of descent of approximately 630 feet per minute, the airplane began to roll out of a 22 degree right bank as the heading reached 171 degrees and the radio altitude decreased to approximately 270 feet. During the next 12 seconds, the airplane rolled nearly wings level as the heading reached 192 degrees and the radio altitude decreased to 140 feet. At this point in the flight the data shows the airplane entering a series of roll oscillation[s] accompanied by left side stick control roll axis inputs. The roll oscillations persisted for the next 30 seconds reaching maximum bank angles of -15.5 and 12.3 degrees. The side stick roll axis inputs also persisted through out this period reaching full travel (+/- 20 degrees) during most of the period. A missed approach was executed approximately 12 seconds after the start of the roll oscillations."

A review of the data for the second landing approach revealed, "The second approach ... was normal until approximately 10 seconds before main gear touchdown. At this point in the approach the lateral acceleration values began a negative trend which persisted for 8 seconds reaching a peak value of -0.1 "G". At the beginning of this 8 second period, the radio altitude was 86 feet and the roll attitude was approximately wings level. During this period, the left side stick controller roll axis inputs began to oscillate, increasing in magnitude and frequency. The lateral acceleration values returned to approximately 0.0 "G" 3 seconds prior to main gear touchdown. However, during this 3 second period the left side stick controller roll axis inputs increased to full travel (+/- 20 degrees) and the roll values fluctuated between 7 and -4 degrees. Vertical acceleration values of 1.36 and 1.63 "Gs" were recorded 2 seconds apart during main gear touch down."

Tests and Research

The airplane was being landed with 20 degrees of flaps [referred to as the CONF 3]. Northwest Airlines reported they use this flap configuration while landing at Washington National Airport for noise abatement purposes. According to Airbus Industrie, CONF 3 was originally designed to be used for takeoffs and landings in adverse atmospheric conditions. The airplane response in this configuration was described as "more crisp". Airbus reported, "However, some airline pilots are more prone to overreacting than others, especially in turbulent conditions close to the ground. And in that case, the quicker aircraft response together with the pilot's overreaction can lead to PIO [pilot induced oscillations]." 'Aerodynamics for Naval Aviators' states that: "The pilot-induced oscillation is most likely under certain circumstances. Most obvious is the case of the pilot unfamiliar with the "feel" of the airplane and likely to overcontrol or have excessive response lag."

In April, 1993, Airbus issued Temporary Revision 192 (TR 192) to the Flight Crew Operating Manual (FCOM) for the A320 aircraft. Tr 192 addressed the flap settings to be used while landing in turbulence or suspected windshear. This TR stated that full flaps and not CONF 3 should be used for landing in these condition. The TR stated, "... a small number of cases where pilots making approaches in CONF 3 in gusty turbulent conditions have experienced lateral control difficulties." Northwest Airlines had not incorporated this TR information into its FCOMs.

Due to this phenomena, Airbus developed a ELAC (Elevator Aileron Computer) software modification, known as L69J, so that the aircraft lateral response to control inputs in CONF 3 is equal to the response of CONF Full [full flaps] which is less sensitive. Airbus Industrie Service Bulletin No. A320-27-1082, addressing the software update was issued on April 25, 1995. The ELAC software utilized on N331NW at the time of the incident was known as L62C.

Pilot Information

Certificate:	Airline Transport; Flight Engineer	**Age:**	, Male
Airplane Rating(s):	Multi-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Unknown	**Last FAA Medical Exam:**	03/02/1995
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	4692 hours (Total, all aircraft), 1155 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus Industrie	**Registration:**	N331NW
Model/Series:	A320-211 A320-211	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	318
Landing Gear Type:	Retractable - Tricycle	**Seats:**	156
Date/Type of Last Inspection:	Continuous Airworthiness	**Certified Max Gross Wt.:**	145000 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:		**Engine Manufacturer:**	GE
ELT:	Installed, not activated	**Engine Model/Series:**	CFM-56-5
Registered Owner:	NORTHWEST AIRLINES, INC.	**Rated Power:**	23500 lbs
Operator:	NORTHWEST AIRLINES, INC.	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:	NORTHWEST AIRLINES	**Operator Designator Code:**	NWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	DCA, 16 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	1653 EDT	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Scattered / 5500 ft agl	**Visibility**	15 Miles
Lowest Ceiling:	Broken / 25000 ft agl	**Visibility (RVR):**	0 ft
Wind Speed/Gusts:	17 knots / 25 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	220°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	25°C / 7°C
Precipitation and Obscuration:			
Departure Point:	MINNEAPOLIS, MN (MSP)	**Type of Flight Plan Filed:**	IFR
Destination:	(DCA)	**Type of Clearance:**	IFR
Departure Time:	1538 EDT	**Type of Airspace:**	Class B

Airport Information

Airport:	WASHINGTON NATIONAL (DCA)	**Runway Surface Type:**	
Airport Elevation:	16 ft	**Runway Surface Condition:**	
Runway Used:	18	**IFR Approach:**	Visual
Runway Length/Width:	6869 ft / 150 ft	**VFR Approach/Landing:**	Go Around

Wreckage and Impact Information

Crew Injuries:	5 None	**Aircraft Damage:**	None
Passenger Injuries:	103 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	108 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	PAMELA S SULLIVAN	**Report Date:**	04/29/1996
Additional Participating Persons:	ROBERT HENLEY; WASHINGTON, DC HELENE LANDURE; LE BOURGET, OF MARTEN BOSMAN; TOULOUSE, OF TIMOTHY LOGAN; ST. PAUL, MN		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		